



## **Fire Fighter Has Unwitnessed Sudden Cardiac Death at Fire Station - Massachusetts**

### **SUMMARY**

On March 16, 1999, a 56-year-old male fire fighter had just finished dressing for his work shift when he and his crew were toned out for a nearby motor vehicle accident. The victim never joined the response. Approximately 20 minutes later, as fire fighters returned from the incident to the fire station, they found the victim unresponsive, without a pulse or respirations. Despite cardiopulmonary resuscitation (CPR), including the use of semi-automatic external defibrillators (SAED) administered by fire fighters, and advanced life support (ALS) administered by ambulance paramedics and hospital emergency department personnel, the victim died. The death certificate, completed by the Certifying Physician, listed "asystole" as the immediate cause of death, due to "coronary artery disease." No autopsy was performed.

Other agencies have proposed a three-pronged strategy for reducing the risk of on-duty heart attacks, cardiac arrests, and sudden cardiac death among fire fighters. This strategy consists of (1) minimizing physical stress on fire fighters; (2) screening to identify and subsequently rehabilitate high risk individuals; and (3) encouraging increased individual physical capacity. Issues relevant to this fire department include

- ***Fire Fighters should have annual medical evaluations to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others. The Department and Union should negotiate the content and frequency to be consistent with NFPA 1582.***

- ***Provide fire fighters with medical evaluations to wear self-contained breathing apparatus (SCBA).***
- ***Recommend to the Medical Examiner / Certifying Physician that an autopsy should be performed on all on-duty fire fighters whose death may be cardiovascular-related.***
- ***Reduce risk factors for cardiovascular disease and improve cardiovascular capacity by phasing in a mandatory wellness/fitness program negotiated between the Fire Department and the Union.***

### **INTRODUCTION & METHODS**

On March 16, 1999, a 56-year-old male fire fighter was found in cardiac arrest at the fire station. Despite CPR and ALS administered by his company, ambulance paramedics, and emergency department personnel, the victim died. NIOSH was notified of this fatality on March 23, 1999, by the United States Fire Administration. On April 14, 1999, NIOSH contacted the affected fire department to initiate the

The **Fire Fighter Fatality Investigation and Prevention Program** is conducted by the National Institute for Occupational Safety and Health (NIOSH). The purpose of the program is to determine factors that cause or contribute to fire fighter deaths suffered in the line of duty. Identification of causal and contributing factors enable researchers and safety specialists to develop strategies for preventing future similar incidents. To request additional copies of this report (specify the case number shown in the shield above), other fatality investigation reports, or further information, visit the Program Website at:

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investigation. On June 21, 1999, a Senior Medical Epidemiologist from the NIOSH Fire Fighter Fatality Investigation Team and a NIOSH Industrial Hygienist traveled to Massachusetts to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel met with and interviewed

- The Commissioner of the Fire Department (FD)
- Deputy Fire Chief
- District Fire Chief and Assistant to the Commissioner
- FD Medical Director
- Fire fighters who first found the victim unconscious

During the site visit NIOSH personnel reviewed

- Existing FD investigative records, including the board of inquiry report, incident reports, co-worker statements, and dispatch records;
- The victim's personnel and medical file maintained at the FD;
- Emergency medical services—ambulance report;
- Death certificate of the deceased;
- Past medical records of the deceased;
- FD policies and operating procedures;
- FD training records;
- The FD annual report for 1998.

NIOSH personnel also

- Contacted by telephone the Local Vice President of the International Association of Fire Fighters (IAFF);
- Visited the fire station and room where the victim collapsed;
- Contacted the family's legal representative by telephone.

### **INVESTIGATIVE RESULTS**

*Incident Response.* On March 16, 1999, at 0759 hours, Engine 48 and Ladder 28 received a still alarm for a motor vehicle accident (MVA) that occurred just outside the fire station entrance. At the MVA scene, one of the responding fire fighters noted that the victim, who reported for duty earlier that morning, was not present. The fire companies returned to the station at 0815 hours and shortly thereafter found the victim in uniform lying face down on the floor between two beds in the bunkroom. The victim had apparently collapsed sometime between 0745-0800 hours. The first firefighter to find the victim attempted to awaken him by rolling him over on his back. At this time he noted the victim had a cut on the side of his head, was not breathing, and had no pulse. Trained as an emergency medical technician (EMT), the fire fighter administered a quick breath via mouth-to-mouth resuscitation and then called for help. CPR was immediately initiated by nearby fire fighters as Central Dispatch was notified that a fire fighter had experienced a cardiac arrest at the fire station (0820 hours). Other company fire fighters retrieved and inserted an oral airway and administered oxygen while attaching the chest leads of the SAED. All fire apparatus carry SAED, and all Fire Department fire fighters are trained in their use. CPR was halted while the SAED analyzed the victim's heart rhythm—no shock was advised, and CPR was re-initiated. This sequence of events, CPR halted while SAED analyzed the victim's rhythm, was repeated three times over several minutes; each time the SAED advised no shock. A second SAED machine was attached to the chest leads, only to have the same interpretation: "advise no shock."

The ambulance arrived on scene with two paramedics at 0831 hours. They found the victim unconscious with no pulse or respirations. CPR was in progress with a patent (open) airway and no heart beat (asystole) on the heart monitor. They intubated, gained intravenous access, and administered



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medications consistent with ALS protocols. At 0853 hours they departed the fire station for the hospital emergency department and arrived at 0902 hours without a change in the victim's status.

Once in the emergency department, the victim was reassessed and placement of the endotracheal tube and intravenous lines were re-checked. CPR and ALS were continued for an additional 14 minutes. At 0916 hours the victim was pronounced dead, and resuscitation efforts were discontinued.

*Medical Findings.* The death certificate was completed in the hospital's emergency department by the treating physician (Certifying Physician), who listed "asystole" as the immediate cause of death due to "coronary artery disease." Medical records indicated that the victim had four known risk factors (advancing age, male gender, cigarette smoking, and hypertension) for coronary artery disease (CAD). Company fire fighters reported that the victim did not exercise regularly, while another fire fighter reported that he was an avid golfer and walked on a regular basis. Company fire fighters stated the victim never complained of chest pain or other symptoms suggestive of angina at the fire station or while performing fire suppression duties.

The day of the incident the victim arrived at the fire station at approximately 0745 to begin his shift at 0800. While changing clothes and preparing for duty, the victim did not report or show signs of discomfort, pain, or distress. Whether the victim collapsed prior to the alarm or just after the alarm cannot be ascertained from the facts of the case or from witnesses.

#### **DESCRIPTION OF THE FIRE DEPARTMENT**

At the time of the NIOSH investigation the fire department was comprised of 1,591 uniformed

personnel and served a population of 570,000 residents and a daily workforce population of 1.2 million in a geographic area of 45 square miles. The housing density is 12,600 persons per square mile. Fire fighters work the following tour of duty at 34 fire stations: Day 1, 0800-1800; Day 2, 1800-0800; Day 3, off duty; Day 4, 0800-1800; Day 5, 1800-0800; Days 6, 7, and 8, off duty. There are 4 work groups. Each shift of an engine company is staffed with an officer and three fire fighters; each ladder company, an officer and four fire fighters. The emergency medical service is also a city resource but separate from the fire department.

In 1998, the department responded to 71,961 total calls: 28,684 rescue/emergency medical services (EMS) calls, 15,344 service calls, 10,731 good-intent calls, 9,951 false alarms, 4,874 fires or explosions, 2,288 hazardous conditions, 15 overpressure/ruptures, 9 natural disaster incidents, and 65 other situations.

*Training.* The fire department provides all new fire fighters with the basic 13-week recruit training conducted at the city's Drill School, to become certified to the NFPA Fire Fighter I and II levels. All are certified First Responders and are SAED-certified. All new fire fighters must become EMT-Basic certified within 1 year of employment. The department also requires annual completion of the Back-to-Basics training program and SCBA maze training. The victim had 29 years of fire fighting experience and was a certified Fire Fighter.

*Pre-employment/Pre-placement Evaluations.* The department currently requires a pre-employment/pre-placement medical evaluation for all new hires, regardless of age. This medical evaluation was not in place at the time the victim was hired, 29 years ago. Components of this current evaluation for all applicants include the following:



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- A complete medical history
- Height, weight, and vital signs
- Physical examination
- Vision test
- Hearing test
- Complete blood count (CBC)
- Blood lipid profile (total cholesterol, HDL cholesterol, triglycerides)
- Blood chemistries (SMA 12)
- Urinalysis
- Urine and hair drug test
- X-rays (chest, knees, spine)
- Pulmonary function tests (lung tests)
- Exercise electrocardiogram (stress or treadmill test)
- PPD test (skin test for tuberculosis)

These evaluations are performed by a contractor hired by the fire department with results forwarded to the fire department physician. Once this evaluation is complete, a decision regarding medical clearance for fire fighting duties is made. As required by State law, employees hired since November 1996 have been required to pass a physical ability test. This is a timed performance evaluation of typical fire fighting duties. Finally, all fire fighters are required to pass a self-contained breathing apparatus (SCBA) performance test (i.e., using an SCBA in a maze). Medical clearance for SCBA use prior to this test is not required.

Periodic Evaluations.

No annual/periodic medical evaluations are required by this department. If an employee is injured at work, he/she must be cleared for "return to work." This clearance must go through the fire department physician. For employees hired after November 1996, the State has passed legislation requiring biannual physical ability tests (PAT). Confusion regarding the funding of this requirement, placement of fire fighters who have failed the test, and the frequency of the test, have caused many

departments, including this one, to put the biannual PAT on hold. Some stations have exercise (strength and aerobic) equipment, typically purchased by the fire fighters themselves, but no voluntary or required fitness/wellness program exists. SCBA performance tests are conducted on an annual basis, although no specific medical clearance for SCBA use is required.

**DISCUSSION**

In the United States, coronary artery disease (atherosclerosis) is the most common risk factor for cardiac arrest and sudden cardiac death.<sup>1</sup> Risk factors for its development include increasing age, male gender, family history of coronary artery disease, smoking, high blood pressure, high blood cholesterol, diabetes mellitus, and obesity/physical inactivity.<sup>2</sup> The victim had four of these risk factors: advancing age, male gender, cigarette smoking, and high blood pressure. Although an autopsy was not performed to confirm the presence of atherosclerosis, it was probably present in this individual based on his risk factors and his acute demise.

The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades.<sup>3</sup> However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion.<sup>4</sup> Heart attacks typically occur with the sudden development of complete blockage (occlusion) in one or more coronary arteries that have not developed a collateral blood supply.<sup>5</sup> This sudden blockage is primarily due to blood clots (thrombosis) forming on the top of atherosclerotic plaques. Again, since an autopsy was not performed, we cannot confirm that a blood clot (thrombosis) occurred or even that a heart attack (myocardial infarction) occurred. Nonetheless, we consider this the most likely scenario leading to his cardiac arrest (asystole).

Firefighting activities are strenuous and often require fire fighters to work at near maximal heart rates for



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long periods. The increase in heart rate has been shown to begin with responding to the initial alarm and persist through the course of fire suppression activities.<sup>6-8</sup> Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks.<sup>9-12</sup> We cannot determine whether the mental and physical stress of preparing to respond to the alarm contributed to this victim's cardiac arrest and subsequent sudden (presumed) cardiac death. This victim did not report prior episodes of angina (heart pain) during physical activity performed on or off the job. But sudden cardiac death is often the first overt manifestation of ischemic heart disease.<sup>13</sup>

Discrepancies existed in the frequency and content of the Fire Department's and the Union's negotiated medical evaluation and those recommended by the NFPA.<sup>14</sup> For example, the Fire Department conducts extensive pre-employment/pre-placement medical evaluations, including treadmill stress tests on all applicants, regardless of age. The NFPA recommends stress tests for those 35 years old and above with known CAD risk factors and 40 years old and above for those without CAD risk factors.

Another discrepancy is the lack of annual medical evaluations by the department. NFPA recommends annual medical evaluations on all fire fighters, regardless of age, conducted by a physician and consisting of (1) an update of the fire fighter's medical history (including any significant changes, a brief review of symptoms, and a report on any significant job-related exposures experienced during the past year), (2) height and weight, (3) visual acuity, (4) blood pressure, and (5) any additional testing depending on the fire fighter's medical condition.

A more thorough evaluation, including a medical examination, is conducted on a periodic basis depending on the age of the fire fighter. For individuals less than 30 years of age, every 3 years;

for those 30 to 39, every 2 years; for those 40 and over, every year. The recommended content of this evaluation includes (1) an updated medical and interval history, (2) complete physical examination, (3) vision testing, (4) audiometry, (5) pulmonary function testing, (6) complete blood count, (7) urinalysis, (8) biochemical (blood) test battery, and (9) exercise stress (treadmill) tests. As mentioned above, the NFPA recommends stress tests at least every 2 years for those 35 years old and above with known CAD risk factors and 40 years old and above for those without CAD risk factors. This exercise stress testing procedure has errors both in over-diagnosis and in under-diagnosis, although newer techniques including the use of Thallium administration or additional monitoring can improve the accuracy of the procedure.<sup>15</sup> It is thus possible to detect coronary artery disease in asymptomatic fire fighters before an event such as a myocardial infarction occurs.<sup>16</sup> If a treadmill test had been performed on this fire fighter, his underlying CAD may have been identified and he would then probably have been directed toward further evaluation and treatment.

### **RECOMMENDATIONS AND DISCUSSION**

The following recommendations address health and safety generally. This list includes some preventive measures that have been recommended by other agencies to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. These recommendations have not been evaluated by NIOSH but represent research presented in the literature or consensus votes of Technical Committees of the National Fire Protection Association or labor/management groups within the fire service. In addition, they are presented in a logical programmatic order, and are not listed in a priority manner.

***Recommendation #1: Fire Fighters should have annual medical evaluations to determine their***



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*medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others. The Department and Union should negotiate the content and frequency to be consistent with NFPA 1582.*

Guidance regarding the content and scheduling of periodic medical examinations for fire fighters can be found in NFPA 1582, Standard on Medical Requirements for Fire Fighters,<sup>14</sup> and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs wellness/fitness initiative.<sup>17</sup> The department is not legally required to follow any of these standards. Nonetheless, we recommend the City and Union negotiate the content and frequency to be consistent with the above guidelines.

Specifically, according to NFPA 1582, the pre-employment/pre-placement stress (EKG) tests are not necessary for applicants under the age of 35. Additionally, pre-placement screening radiography (X-rays) of the low back lack clinical and predictive value while exposing the candidate to unnecessary radiation.<sup>18</sup> Both of these screening tests represent an unnecessary expense for the department.<sup>18</sup> On the other hand, annual/periodic medical evaluations should be conducted, and, according to the NFPA, should include stress tests for fire fighters with risk factors for CAD, beginning at age 35.

In addition to providing guidance on the frequency and content of the medical evaluation, NFPA 1582 provides guidance on medical requirements for persons performing fire fighting tasks. Applying NFPA 1582 involves legal issues, so it should be carried out in a **confidential, nondiscriminatory** manner. Appendix D of NFPA 1582 provides guidance for Fire Department Administrators regarding legal considerations in applying the standard.

Applying NFPA 1582 also involves economic issues. These economic concerns go beyond the costs of administering the medical program; they involve the personal and economic costs of dealing with the medical evaluation results. NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, addresses these issues in Chapter 8-7.1 and 8-7.2.<sup>19</sup> The success of medical programs hinges on protecting the affected fire fighter.

***Recommendation #2: Provide fire fighters with medical evaluations to determine their fitness to wear self-contained breathing apparatus (SCBA).***

In 1997, OSHA published its revised respiratory protection standard.<sup>20</sup> This standard, among other things, requires that a medical evaluation of fire fighters wearing SCBA be performed by a physician or other licensed health care professional. This evaluation could consist of a screening questionnaire (enclosed) to ascertain if additional medical evaluations or a medical examination is warranted. Because Massachusetts does not have an Occupational Safety and Health Administration (OSHA)- approved state plan, its state and municipal employees, such as fire fighters, are not covered under the Occupational Safety and Health Act, which governs OSHA. Therefore, State, County, or City fire departments in Massachusetts are **NOT** required to comply with OSHA standards. Nonetheless, we recommend voluntary compliance with the respiratory protection standard to ensure that fire fighters can safely wear SCBA.

***Recommendation #3: Recommend to the Medical Examiner /Certifying Physician that an autopsy should be performed on all on-duty fire fighters whose death may be cardiovascular-related.***



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In 1995, the United States Fire Administration (USFA) published the *Firefighter Autopsy Protocol*.<sup>21</sup> This publication hopes to provide “a more thorough documentation of the causes of firefighter deaths for three purposes:

- (1) to advance the analysis of the causes of firefighter deaths to aid in the development of improved firefighter health and safety equipment, procedures, and standards;
- (2) to help determine eligibility for death benefits under the federal government’s Public Safety Officer Benefits Program, as well as state and local programs; and
- (3) to address an increasing interest in the study of deaths that could be related to occupational illnesses among firefighters, both active and retired.”

***Recommendation #4: Reduce risk factors for cardiovascular disease and improve cardiovascular capacity by phasing in a mandatory wellness/fitness program negotiated between the Fire Department and the Union.***

In 1997, the International Association of Fire Fighters and the International Association of Fire Chiefs joined in a comprehensive Fire Service Joint Labor Management Wellness/Fitness Initiative to improve fire fighter quality of life and maintain physical and mental capabilities of fire fighters. Ten fire departments across the United States joined this effort to pool information about their physical fitness programs and to create a practical fire service program. They produced a manual with a video detailing elements of such a program.<sup>17</sup> The Fire Department and the Union should review these materials to identify and **negotiate** applicable elements for their department. Other large-city

negotiated programs can also be reviewed as potential models.

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